Section 2.0 of the Los Angeles to San Diego via Orange County Alignment / Station Screening Evaluation Methodology

2.0 PARAMETERS/ASSUMPTIONS AND EVALUATION METHODOLOGY

Unless otherwise noted, the objectives, parameters, criteria, and methodologies described in this report are consistent with those applied in previous California high-speed train studies and documented in the *California High-Speed Train Program EIR/EIS*, *Task 1.5.2 – High-Speed Train Alignment/Station Screening Evaluation Methodology*.[11]

2.1 PARAMETERS AND ASSUMPTIONS

High-speed train alignment and station options were developed through consistent application of system, engineering, and operating parameters as described in Task 1.5.2. The parameters and assumptions applied are consistent with those applied in previous planning and engineering studies and are based on accepted engineering practice, the criteria and experiences of other railway and high-speed train systems, and recommendations of VHS and maglev manufacturers.

2.1.1 Statewide Parameters/Assumptions

The design, cost, and performance parameters used in developing the alignment and station options are based on two technology groups (classified by speed) (Figure 2.1.1). The Very High Speed (VHS) group includes trains capable of maximum operating speeds near 220 mph (350 km/h) utilizing steel-wheel-on-steel-rail technology. Requirements for a VHS system include a dedicated, fully grade-separated right-of-way with overhead catenary for electric propulsion. It is possible to integrate a VHS system into existing conventional rail lines in congested urban areas given resolution of certain equipment and operating compatibility issues. The magnetic levitation (Maglev) group utilizes magnetic forces to lift and propel the train along a guideway and is designed for maximum operating speeds above that of VHS technology. A maglev system requires a dedicated guideway and may share right-of-way BUT not track with conventional train systems.

Figure 2.1-1
VHS and Maglev Technology

VHS Train (Germany ICE)

Maglev (Transrapid)

[11] Parsons Brinckerhoff. *California High-Speed Train Program EIR/EIS, Task 1.5.2 – High-Speed Train Alignments/Stations Screening Evaluation Methodology*. Prepared for California High-Speed Rail Authority, May 2001.

High-speed train system engineering design parameters used in developing the alignments were documented in Task 1.5.2 and include speeds, geometry, and clearances for both steel-wheel-on-steel-rail (VHS) and maglev high-speed train technologies. The parameters and criteria, summarized in Table 2.1-1, are consistent with previous California high-speed train studies and are based on accepted engineering practice, the criteria and experiences of other railway and high-speed train systems, and recommendations of VHS and maglev manufacturers.

Table 2.1-1
Summary of Engineering Design Parameters

Parameter	Very High-Speed	Maglev
Double Track	Full	Full
Power Source	Electric	Electric
Grade-Separations	Full	Full
POTENTIAL FOR SHARED-USE	Yes	No
Corridor Width ❑ **Desirable** ❑ **Minimum**	 100 ft (30.4 m) 50 ft (15.2 m)	 100 ft (30.4 m) 50 ft (15.2 m)
Top Speed	220 mph (350 km/h)	240 mph(1) (385 km/h)
Average Speed	125-155 mph (200-250 km/h)	145-175 mph (230-280 km/h)
Acceleration	0.4-1.3 mph/s(3) (0.6-2.1 km/h/s(4))	1.1-1.9 mph/s (1.8-3.2 km/h/s)
Deceleration	1.2 mph/s (1.9 km/h/s)	1.8 mph/s (2.9 km/h/s)
MINIMUM HORIZONTAL RADIUS	500-650 ft (150-200 m)	1,150 ft (350 m) (2)
Minimum Horizontal Radius (at top speed)	15,600 ft @ 220 mph (4,750 m @ 350 km/h)	11,500 ft @ 240 mph (3,500 m @ 385 km/h)
Superelevation ❑ **Actual (Ea)** ❑ **Unbalanced (Eu)**	 7 in (180 mm) 5 in (125 mm)	 16° 5°
Grades ❑ **Desirable Maximum** ❑ **Absolute Maximum**	 3.5% 5.0%	 NA 10.0%
Minimum Vertical Radius Crest Curve (at top speed)	157,500 ft @ 220 mph (48,000 m @ 350 km/h)	205,700 ft @ 240 mph (62,700 m @ 385 km/h)
Minimum Vertical Radius Sag Curve (at top speed)	105,000 ft @ 220 mph (32,000 m @ 350 km/h)	137,100 ft @ 240 mph (41,800 m @ 385 km/h)
Horizontal Clearance (centerline of track to face of fixed object)	10 ft 4 in @ 220 mph (3.1 m @ 350 km/h)	9 ft 5 in @ 240 mph (2.8 m @ 385 km/h)
Vertical Clearance (top of rail to face of fixed object)	21 ft (6.4 m)	12 ft 2 in (3.7 m)
Track Centerline Spacing	15 ft 8 in @ 220 mph (4.7 m @ 350 km/h)	15 ft 9 in @ 240 mph (4.8 m @ 385 km/h)
Minimum Right-of-Way Requirements At-Grade/Cut-and-Fill/Retained Fill Aerial Structure Tunnel (Double Track) Tunnel (Twin Single Track) Trench/Box Section	 50 ft (15.2 m) 50 ft (15.2 m) 67 ft (20.4 m) 120 ft (36.6 m) 70 ft (21.3 m)	 47 ft (14.3 m) 49 ft (15 m) 67 ft (20.4 m) 120 ft (36.6 m) 73 ft (22.2 m)
Minimum Station Platform Length	1,300 ft (400 m)	1,300 ft (400 m)
Minimum Station Platform Width	30 ft (9 m)	30 ft (9 m)

Notes: 1- Top Speed Defined in Federal Maglev Deployment Plan
2- Transrapid USA, 1998.
3- mph/s – miles per hour-second
4- km/h/s – kilometers per hour-second

Based on the minimum requirements listed in Table 2.1-1, three general right-of-way parameters were utilized for the screening evaluation: (1) a minimum right-of-way corridor of 50 feet (15.2 meters) was assumed in congested corridors; (2) a 100-foot (30.4-meter) corridor was assumed in less developed areas to allow for drainage, future expansion and maintenance needs; and (3) a wider corridor was assumed in variable terrain to allow for cut and fill slopes and tunnels.

The overall operations strategy and conceptual service parameters that were assumed for high-speed train service in California are documented in Task 1.5.2. Specific scheduling and operations modeling analysis is currently underway and will be used in future detailed engineering and environmental analyses in the next phase of this study.

2.1.2 LOSSAN Corridor Parameter/Assumption Variances

Of the five corridors being studied by the Authority, the Los Angeles – Orange County – San Diego corridor is unique in that it contains, from end to end, an existing intercity passenger rail corridor – the Los Angeles to San Diego (LOSSAN) corridor. In terms of passenger volumes, the LOSSAN corridor is Amtrak's second-busiest corridor in the nation, after the Northeast Corridor connecting Washington, D.C. to New York City. It is used by Amtrak for the State-supported Pacific Surfliner Service between Los Angeles and San Diego, by the Southern California Regional Rail Authority for its Metrolink commuter rail service in Los Angeles and Orange Counties, and in San Diego County by the North County Transit District for its Coaster commuter rail service. Burlington Northern Santa Fe also uses the corridor for freight service.

The presence of the LOSSAN corridor provides an excellent opportunity, as it raises the possibility of building a high-speed train system by incrementally improving an existing service, including the possibility of using conventional fossil-fuel trains rather than electrically powered steel-wheel-on-steel-rail or Maglev technologies. Therefore, in addition to considering alignment options, this study examines two levels of incremental improvements to the LOSSAN corridor that would support different levels of high-speed service, as alternative high-speed train "build" options.

However, the corridor also poses some considerable constraints. It passes through one of the most densely populated areas of the State and, in southern Orange County and San Diego County, traverses ecologically sensitive coastal areas. Due to these significant environmental and community constraints, the LOSSAN options would not be dedicated services. The options either require high-speed trains to share tracks with existing Amtrak, commuter rail and freight service, or would be a separate "feeder" service that would require a transfer to the rest of the high-speed network, at LA Union Station or in Orange County.

A. HIGH-SPEED TRAIN TECHNOLOGIES

Due to significant constraints within this corridor, the alternatives proposed for study are restricted largely to existing transportation corridors – freeways and rail lines. In addition, within the LOSSAN corridor itself, options are being examined that would allow high-speed trains to share tracks with existing Amtrak, commuter rail, and freight services. The intent is not to mix high-speed trains traveling at more than 200 mph (320 km/h) with other rail traffic; in urban areas, the speeds of high-speed trains would be approximately the same as other passenger services. However, by sharing tracks, the intent is to minimize community and environmental impacts while allowing travelers easy access the statewide system.

Given the variety of system configuration options outlined on the previous pages, several different High-Speed (HS) and Very High-Speed (VHS) train technologies were modeled in this corridor. Both electric and fossil-fueled high-speed trains were modeled.

The electric locomotive, the Alstom AEM-7, is currently used in Amtrak's Acela Regional Service (not to be confused with the newer Bombardier vehicle in Acela Express service). This locomotive is capable of accelerating quickly to 125 mph (200km/h). The model in these simulation studies was based on an eight-car train set (two power cars and six passenger cars). This locomotive complies with the Federal Railroad Administration's (FRA) high Crash Energy Management (CEM) requirements and is suitable for shared-use with freight and other passenger service.

The diesel-turbine version of Bombardier's Acela HS locomotive is not yet in revenue service. This locomotive is currently under FRA testing at Pueblo, Colorado test track. It is capable of accelerating to top speeds in the 125-150 mph (200-240km/h) range and has been designed to meet FRA CEM requirements. Fossil fuel locomotives typically have slower acceleration rates than electric vehicles. This technology may be marginally slower than the AEM-7, but travel times will be comparable.

The electric German InterCity Express, commonly known as the ICE 3, was used to model VHS Trains in this corridor. This newer technology has several years of proven service. Instead of separate power cars and passenger cars, power is distributed among all the cars in each consist. The ICE 3 is capable of a top speed of 186 mph (300km/h), and has good acceleration abilities. However, this vehicle is not in service in the U.S., and does not conform to FRA CEM requirements. Reconfiguring the ICE 3 to meet these requirements is likely to add a considerable amount of weight and thus impair acceleration. The model in these simulation studies was consistent with the HS model, and was based on an eight-car train.

B. SYSTEM CONFIGURATION OPTIONS (LOSSAN CORRIDOR)

As studied in this report, the range of LOSSAN options are bracketed by the following two representative configurations:

1. LOSSAN Configuration A - Upgrade the existing LOSSAN corridor with full double-tracking and partial grade-separation to allow rail services to operate at up to 125 mph (200 km/h). All existing Amtrak stations would continue to be served by both existing and high-speed trains. This option assumes a conventional fossil-fuel train system that would not be compatible with the rest of the statewide network. This would require passengers to transfer to and from the rest of the statewide train system at LA Union Station in Los Angeles. Within this screening evaluation, this configuration is represented by alignment options B1a, C1a, and D1a.

2. LOSSAN Configuration B - Upgrade the LOSSAN corridor to full high-speed train standards, including complete grade separation, to permit rail services to travel over 125 mph (200 km/h) in some areas, and allow through-running of trains from other parts of the statewide system. High-speed trains would serve only designated stations, with bypass tracks provided where feasible at all stations including existing Amtrak and commuter rail stations to facilitate express operations. Due to the existing geometry of the LOSSAN corridor, and requirement for shared-use, speeds will not be as high as proposed for other segments of the statewide network. This configuration includes alignment options B1b, C1b, and D1b, and represents the highest level of capital improvements studied for an electrified, fully grade-separated system. The physical upgrades embodied in this option can occur with or without electrification. Without electrification, the "b" option encompasses the highest level of capital improvements studied with a conventional fossil-fueled system.

For the sake of simplicity the LOSSAN "a" and "b" options are discussed throughout this report as two distinct options. However, they should be seen as two bookends in what is in fact a continuous spectrum of design options. By drawing selectively from different elements of "a" and "b" in different parts of the corridor, it would be possible to configure a large number of distinct options between the two extremes discussed in this report.

Basic characteristics of the two LOSSAN configurations are summarized in Table 2.1-2, on the following page. Neither of the shared-use configurations is compatible with the maglev technology.

C. LOSSAN CORRIDOR DESIGN VARIANCES

In addition to the parameters in Table 2.1-2, the following variances applied to alignment options in the LOSSAN Corridor:

- Given the shared-use nature of the corridor, grades were limited to 2.5 percent or less, in order to accommodate freight trains.
- Station platforms at LA Union Station, Norwalk, Anaheim, Irvine, Oceanside, University Towne Centre (UTC), and San Diego follow the design parameters in table 2.1-1. The platforms at Solana Beach would be lengthened from existing (if possible) under alignment Option D1b. Station platforms at other Amtrak, Metrolink, and Coaster stations would remain at their current length. At stations where the alignment is grade-separated by the option, vertical circulation to new platforms was assumed.

Table 2.1-2

LOSSAN Shared-Use Improvement Configurations

	A. UPGRADE EXISTING SERVICE FOR HIGHER SPEED	***B. UPGRADE TO HIGH-SPEED TRAIN STANDARDS***
SPEED	UP TO 125 MPH (200 KM/H) *	125 MPH (200 KM/H) AND ABOVE *
TYPES OF TRAFFIC	SHARED-USE: • INTERCITY (e.g. AMTRAK) • COASTER & METROLINK COMMUTER RAIL • FREIGHT	SHARED-USE: • INTERCITY HIGH-SPEED TRAINS • INTERCITY (e.g. AMTRAK) • COASTER & METROLINK COMMUTER RAIL • FREIGHT
TRAVEL FROM SOUTHERN TO NORTHERN CALIFORNIA	DIFFERENT TECHNOLOGY FROM REST OF STATE'S HIGH-SPEED SYSTEM - REQUIRES TRANSFER IN LOS ANGELES OR ORANGE COUNTY	IF CORRIDOR IS ELECTRIFIED, SAME VHS TECHNOLOGY AS REST OF STATE - NO TRANSFER NEEDED
NUMBER OF TRACKS	• DOUBLE-TRACKED EVERYWHERE • THREE OR MORE TRACKS, FULLERTON TO LOS ANGELES	• DOUBLE-TRACKED EVERYWHERE • PASSING TRACKS AT KEY LOCATIONS • FOUR OR MORE TRACKS, FULLERTON TO LOS ANGELES • BYPASS TRACKS AT ALL STATIONS
STATION SPACING	• COMMUTER RAIL: 5 TO 7 MILES (8 TO 11 KILOMETERS) • INTERCITY: 10 TO 15 MILES (16 TO 24 KILOMETERS) • HIGH-SPEED TRAIN: 35 TO 40 MILES (56 TO 64 KILOMETERS)	
VEHICULAR AND PEDESTRIAN GRADE CROSSINGS	• GRADE-SEPARATED AT KEY LOCATIONS	• FULLY GRADE SEPARATED
POWER SOURCE	• FOSSIL FUEL	• FOSSIL FUEL (EXISTING TRAINS) • ELECTRICITY OR FOSSIL FUEL (HS TRAINS)

* *Speeds restricted in urban areas.*

2.2 EVALUATION METHODOLOGY

As listed in Table 2.2-1, a number of key evaluation objectives and criteria were developed based on previous studies with enhancements that reflect the Authority's high-speed train performance goals and criteria described in Task 1.5.2. These objectives and criteria have been applied in the screening of high-speed train alignment and station options developed as part of this process. Each of the evaluation criteria is discussed in Chapter 4.0, Alignment and Station Evaluation.

Except where noted in the following sections, the engineering and environmental methodologies and assumptions used in evaluating the high-speed train alignment and station options are described in detail in Task 1.5.2.

Table 2.2-1
High-Speed Rail Alignment/Station Evaluation Objectives and Criteria

OBJECTIVE	CRITERIA
Maximize Ridership/Revenue Potential	▪ Travel Time ▪ Length ▪ Population & Employment Catchment
Maximize Connectivity and Accessibility	▪ Intermodal Connections
Minimize Operating and Capital Costs	▪ Length ▪ Operational Issues ▪ Construction Issues ▪ Capital Cost ▪ Right-of-Way Issues/Cost
Maximize Compatibility with Existing and Planned Development	▪ Land Use Compatibility and Conflicts ▪ Visual Quality Impacts
Minimize Impacts to Natural Resources	▪ Water Resources ▪ Floodplain Impacts ▪ Threatened & Endangered Species Impacts
Minimize Impacts to Social and Economic Resources	▪ Environmental Justice Impacts (Demographics) ▪ Farmland Impacts
Minimize Impacts to Cultural Resources	▪ Cultural Resources Impacts ▪ Parks & Recreation/Wildlife Refuge Impacts
Maximize Avoidance of Areas with Geologic and Soils Constraints	▪ Soils/Slope Constraints ▪ Seismic Constraints
Maximize Avoidance of Areas with Potential Hazardous Materials	▪ Hazardous Materials/Waste Constraints

2.2.1 Engineering Evaluation Criteria

The engineering evaluation criteria focus on cost and travel time as primary indicators of engineering viability and ridership potential. Items such as capital costs and travel times have been quantified for each of the alignment and station options considered. Other engineering criteria such as operational, construction, and right-of-way issues are presented qualitatively.

The evaluation criteria presented are consistent with the criteria applied in the previous corridor evaluation study and are based on accepted engineering practice, the criteria and experiences of other railway and high-speed train systems, and recommendations of VHS and maglev manufacturers.

A. LOS ANGELES TO SAN DIEGO VIA ORANGE COUNTY ENGINEERING METHODOLOGY VARIANCES

Given the special nature of the alternatives within this corridor, different approaches were needed to estimate travel times and capital costs. Travel time simulations were conducted to determine the achievable speeds and travel times within the existing rail and freeway corridors that make up the alignment options. The capital costs had to be adjusted for alternatives within the LOSSAN corridor because the alignment options involve a mix of new construction and upgrades to existing tracks, stations, bridges, and other railway facilities. The following sections described the methodology variances used for this corridor.

Travel Time Simulations

As noted in Section 2.1, several different HS and VHS train technologies were modeled in this corridor, including diesel and electric HS trains and electric VHS trains. Travel time estimates are included in Appendix A.

A proprietary LEGENDS© train simulation model was used to analyze both alignment and technologies to account for the significant restrictions on many of the available corridors on maximum cruise speeds. The use of this model was based on available horizontal tangent and curve information for each of the four alignment alternatives. Use of this model captured the impacts of tight existing curves that will not permit "typical cruise speeds" characteristic of the HS and VHS technology. The ability to negotiate tight curves is the most significant limiting element in higher speed train technology performance. The simulated travel times provide a realistic representation of speeds and indicate the merit of higher speed technologies on each alignment and the corridor as a whole.

Basic Modeling Parameters: In the train simulation modeling, several parameters had to be set that influence vehicle speed through the alignments:

- Acceleration limits (based on passenger comfort, acceleration, braking, and lateral acceleration limits)
- Superelevation
- Station Dwell time

The lateral acceleration and super elevation are functions of curve radius and will restrict the speed of the train before the curve, require slower speeds through the curve, and allow for acceleration coming out of the curve. These parameters were uniformly defined in the simulation model for the curves in each alignment. The acceleration, braking and lateral acceleration limits were set to 3.22 feet/second^2 (0.98 m/s^2, or 0.1 G) to allow passengers to freely stand and walk about the cabin. Higher acceleration levels would require passengers to remain seated when the train is either accelerating or decelerating. A 10-percent superelevation curve limit was applied to all curves in the alignment alternatives in the simulation model, and speeds in the curves were limited on this basis. However, HS trains can travel at higher speeds when on higher super elevated banks.

The additional parameters that influence train speed in the model include station dwell times, top speeds, and grade climbing ability. The simulation model added two minutes of "dwell" time at each station along the alignment, consistent with the overall methodology. This time is independent of acceleration and deceleration. Top speeds were limited to 125 mph (200 km/h) for HS trains and 186 mph (~300 km/h) for VHS trains. These limits reflect the performance of vehicles currently in service. The simulation model has not yet incorporated any grade assumptions in any of the alignments because no data was available. However, the HS and VHS technologies are designed for 3.5 percent grade capability with minimal speed loss. Most technologies are capable of climbing a five percent grade with considerable vehicle slowing. If the alignments traverse grades greater than 3.5 percent, trip times should be recalculated.

These limits combine to restrict vehicle speeds. The maximum lateral acceleration and superelevation set the speed limits through curves, which are a function of curve radius. These limits force the trains to slow down before many of the curves, and then accelerate after the curves. Some examples of curve speed limits are:

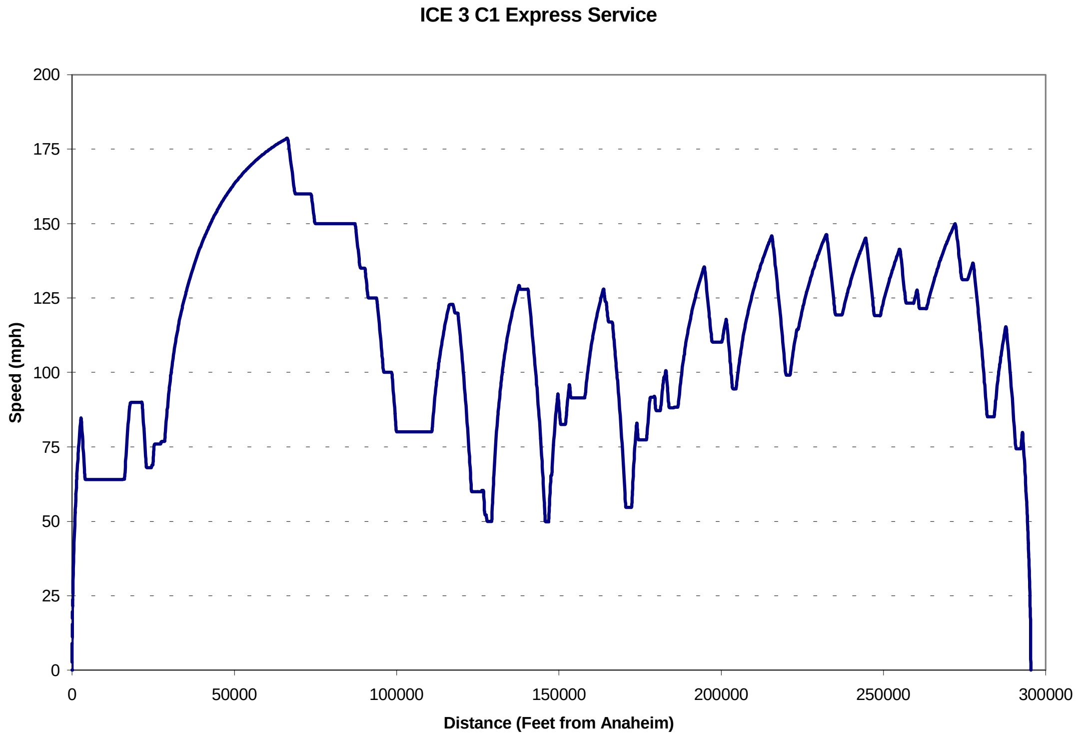
Curve Radius (ft)	Curve Radius (m)	Speed (mph)	Speed (km/h)
1,000	305	55	89
3,000	914	95	153
5,000	1,524	122	196
10,000	3,048	173	278

General Modeling Results: The VHS trip times were obviously shorter than the HS trip times. However, the differences are small due to the alignment curves. Many curves of relatively short radii in these alignments prevent VHS technology from fully utilizing its speed advantage. There are few segments in the alignment where the ICE 3 can remain above 125 mph (200 km/h) for any length of time.

The simulation results verify that allowable curve speeds are the greatest factor in limiting train speed. Curve radii below 10,000 feet (3,125 meters) limit speeds to less than 173 mph (~300 km/h). Most of the curves on the alignment options discussed in this report are well below 10,000 feet (3,125 meters). Hence, there would be very few spans where the VHS top speed of 186 mph (~300 km/h) would be achieved. The simulated trip times of the VHS trains did not significantly outperform the simulated trip times of the HS trains due to the alignment curves. VHS trip times were approximately only five percent lower than HS trip times in all but one section of track in each alignment.

The following speed profile of a VHS train running non-stop from Anaheim to Oceanside on the C1 alignment provides an example of how curves impose speed limitations. The graph shows the speed restrictions in the 50-60 mph (80-96 km/h) range and in the 100-125 mph (160-200 km/h) range that prevent the train from accelerating and holding the top speeds near 186 mph (~300 km/h). The train spends much of the distance restricted below 125 mph (~200 km/h), and nearly all of the distance is restricted below 150 mph (240 km/h). In most of the alignment, there is very little difference between the performance of the VHS locomotive capable of 186 mph (~300 km/h) and the HS locomotive capable of 125 mph (200 km/h). In the few areas where the VHS locomotive reaches top speed, the overall travel times are only five percent shorter than the HS locomotive travel times.

Figure 2.2-1
Simulated Very High-Speed Train Performance on the C1 Alignment



Capital Cost Assumptions

For comparative purposes, capital cost estimates were prepared for the full set of alignment options. Given the preliminary nature of this screening evaluation, specific results have not been published.

LOSSAN Corridor Configurations A and B: The implementation of conventional HS (e.g. Acela) or VHS trains in a shared-use LOSSAN corridor requires some deviation from the standard cost estimating procedure defined in Task 1.5.2 (Screening Methodology).

The No Build condition in the LOSSAN corridor includes a mix of single-, double- and triple-tracked segments. This affects the estimation of quantities and capital costs for the HS and VHS train options corresponding to LOSSAN configurations A and B respectively. This section outlines the modified cost assumptions for the LOSSAN corridor. Certain cost modifications were applied differently to HS and VHS trains.

Track and Guideway: For conventional HS trains (configuration "a"), only new track was considered in the cost estimate. Much of the LOSSAN corridor would require only one new track for configuration "a". Where the alignment is to be re-profiled (tunnel, trench, or aerial), all tracks have been treated as new. VHS trains (configuration "b") would require track and track bed improvements for passenger comfort and equipment maintenance issues throughout the corridor, and all tracks have been treated as new.

The "ballasted track" unit cost (applied to most corridors) is given as $1,257,000 per mile ($781,000 per km) of alignment; this is a double-tracked cost. In areas where a single track is added to the existing corridor for HS trains, this cost would be one half, $628,500 per mile ($392,500 per km).

Likewise, for "direct fixation track", the unit cost is given as $2,376,000 per mile ($1,477,000 per km) of alignment. In areas where adding a single track is proposed for HS trains, this cost would be one half, $1,188,000 per mile ($738,500 per km).

Earthwork and Related Items:

- Earthwork, borrow, and drainage costs are anticipated to be minimal, except where the alignments deviate from the corridor. An average depth of 5 feet (1.5m) of earthwork has been assumed for new alignment and the addition of tracks to the corridor.
- Site preparation and landscaping costs will only be applied to areas of new right-of-way for the alignment, including bypass alignments and corridor widening. (See Right-of-Way)
- Fencing is in place along part of the LOSSAN Corridor, and more would be added for the VHS option (configuration "b") only.

Rail and Utility Relocation: Rail relocation was not assumed. Existing tracks would be used as part of the HS configuration, and replaced in the VHS configuration.

Utility relocation is expected to be less expensive in an existing rail corridor than in new alignments. In general, overhead utilities would already have sufficient clearance, and there would be fewer underground utilities in conflict with an additional track. Therefore, where the No Build track configuration would be retained, no cost for utility relocation has been included. Where a track would being added to the existing corridor, 50 percent of the "new alignment" cost was used. Where the alignment would be new or the profile of the rails is being changed (aerial, trench, or tunnel), the "new alignment" costs were used.

Building Items (Stations): In the LOSSAN Corridor, the proposal would involve extending existing stations (and facilities) or replacing the station. Existing stations represent an opportunity to offset some of the right-of-way, site development, and parking costs. One particular example is the historic Santa Fe Depot in San Diego. The existing station would most likely be expanded to fit the criteria for a terminal station, at less than the full cost of a new station. The costs for expanding existing stations, was assumed to be ten percent lower than new stations.

One of the urban station options (University Towne Centre) would be in a tunnel and have a cost closer to the "terminal" category. In fact, it would be the terminal for some of the dedicated alignments proposed in the Los Angeles to San Diego via Inland Empire corridor of the statewide system. As an order of magnitude estimate, it was assumed that the Terminal Station costs for this location would be used.

One of the operational scenarios features "local" high-speed train service stopping at Fullerton, Santa Ana, San Juan Capistrano, and Solana Beach, in addition to the stops in the *Business Plan*.[12] These additional stops maintain Amtrak service patterns. The standard (Task 1.5.2) costs for major stations from the *Business Plan* (Norwalk, Anaheim, Irvine, Oceanside) and estimates in *Amtrak's California Passenger Rail System 20-Year Improvement Plan*[13] for the other stops (except very short-term funded improvements, within No Build) were used.

Where the alignment is grade-separated (e.g., tunnel or trench) at other Amtrak, Metrolink, or Coaster stations, new platforms, stairs, and elevators are assumed. An allowance of $5 million lump sum (including contingencies) has been made for each affected location.

[12] California High Speed Rail Authority. *Building a High Speed Train System for California, Final Business Plan*. June 2000.
[13] Parsons Brinckerhoff. *California Passenger Rail System 20-Year Improvement Plan*. Prepared for Amtrak, March 2001

Structures/Tunnels/Walls: In this corridor, these items apply where the alignment deviates from the existing LOSSAN corridor, and where grade-separation of the existing alignment is included in the configuration.

- Soundwalls have been included only where widening of the existing corridor is proposed in proximity to noise sensitive land uses.
- Crash walls generally do not apply for this corridor, as shared use is assumed in this rail corridor.

Grade-Separations - LOSSAN: The LOSSAN corridor includes numerous existing grade-separations and grade crossings. The following assumptions were applied:

- For the VHS train configuration ("b"), existing grade crossings would all be grade-separated (either over or under, depending on the proximity of nearby buildings and obstacles).
- The HS and VHS train options include tunnels, trenches, and aerial sections. Grade separation of roads is assumed in these sections. However, where an existing grade-separation is in conflict with the proposed LOSSAN configuration, the cost of a new grade-separation has been assumed. (e.g., an existing undercrossing is replaced by an overcrossing where a trench is proposed.)
- For the HS train configuration ("a"), full grade-separation is not strictly required and only arterial grade crossings have been considered. Other crossings will remain at-grade with protection. All remaining grade crossings are assumed to require quad-gate systems at $400,000 per location.
- Existing road and waterway crossings have not been included in the costs, where the No Build track configuration is sufficient for the HS and VHS configuration.
- Existing single-track waterway crossings and road undercrossings (mostly in southern Orange County and in San Diego County) would be replaced by new (double-track) crossings.
- Existing overcrossings (usually at I-5) would require widening where a track is being added to LOSSAN. Overcrossings modified to add one track are assumed to be 75 percent of the new (double-tracked) cost. The addition of two tracks, at several locations in Los Angeles County, would be 100 percent.
- Where a fourth track is being added, it is assumed that undercrossing and waterway crossing costs are 75 percent of the new (double-tracked) costs.
- At two locations, secondary water crossings are in conflict with trench/tunnel sections of the alignment. An allowance of $5 million (in addition to the standard crossing cost) has been included to rebuild the crossings.

Right-of-Way: Within the existing LOSSAN corridor, there is already rail right-of-way and at least one track. The basic assumption for double-tracked sections is 50 feet (15.6 meters) in urban or suburban areas. The addition of a second track would require 15 to 25 feet (4.7 to 7.8 meters) of additional right-of-way, or 20 feet (6.3 meters) on average. Therefore, where an existing corridor is being widened by one track, 20 feet (6.3 meters) of new right-of-way at 40 percent of the cost of a 50-foot wide strip of land was assumed.

Bypasses and other alignments include new right-of-way: 50 feet (15.6 meters) wide in urban areas, and up to 100 feet (31.3 meters) where available.

Signals and Communication: Where the existing LOSSAN corridor has a sufficient number of tracks (from two to four) in the No Build condition, it is assumed that the HS configuration would not require new signals and communications. All alignment segments (existing or new) where one or more tracks are added would require new signals. The VHS option is assumed to require new signals and communications.

Wayside protection systems are assumed for all alignment segments where the track configuration or profile would be changed or new, and everywhere for VHS.

Electrification: The HS configuration assumes conventional diesel power, and therefore no electrification. VHS includes electrification of the entire alignment.

Special Rail Corridor Projects: Other stakeholders in the LOSSAN corridor, including Amtrak, Caltrans Rail Division, Southern California Regional Rail Authority (SCRRA), and North County Transit District (NCTD), have identified projects to improve passenger rail service in the LOSSAN corridor. Some of these projects are nearing completion or have funding and are considered as part of the No Build alternative. Other projects have been included in the two generic LOSSAN corridor configurations (upgrade to HS, upgrade to HS with VHS path).

For more complex projects, available cost estimates are incorporated where appropriate. Projects of this type include the flyover at Hobart Yard, east of Redondo Junction near downtown Los Angeles.

Capital Cost Assumptions (MTA Green Line Extensions [Option A5])

Typical unit rates for light rail transit (LRT) construction were used to estimate the cost of the elevated light rail extensions to provide a connection from Norwalk to Los Angeles International Airport (LAX).

Capital Cost Assumptions (Other Corridors)

The unit rates from Appendix C of Task 1.5.2 have been used, except for portions of the other alignments (e.g., Options B3, B4) within the LOSSAN corridor.

2.2.2 Environmental Evaluation Criteria

The objectives related to the environment and the criteria used for evaluation are consistent with NEPA and CEQA. The environmental constraints and impacts criteria focus on environmental issues that can affect the location or selection of alignments and stations.

To identify potential impacts for the alignments and station locations, a number of readily available resource agency-approved Geographic Information System (GIS)-compatible digital data sources were used along with published information from federal, state, regional, and local planning documents and reports. For evaluation of alignments and stations, right-of-way widths dictated by engineering requirements were utilized to identify the amount of area within each segment containing certain characteristics. Some environmental issues required using various buffer widths that extended beyond the conceptual right-of-way for the segments. Where noted in section 4.0, field reconnaissance was required to view on-the-ground conditions and to provide relative values of certain resources.